



January 31, 2022

Marlene H. Dortch, Secretary  
Federal Communications Commission  
45 L Street, NE  
Washington, D.C. 20554

Re: **WC Docket No. 17-84, *Accelerating Wireline Broadband Deployment by Removing Barriers to Infrastructure Investment***

Dear Ms. Dortch:

The Schools, Health & Libraries Broadband (SHLB) Coalition is pleased to submit this letter into the record of the above-referenced proceeding.

As set forth in SHLB's prior submissions, cost-efficient and timely access to poles and rights-of-way remains a significant impediment to broadband deployment in this country.<sup>1</sup> A [2021 nationwide survey of pole attachment policies by Connect the Future](#) -- attached to this letter -- found that every month of delayed broadband expansion due to pole delays costs taxpayers between \$491 million and \$1.86 billion.

As unprecedented federal and state funding resources are now being distributed for the deployment of broadband, SHLB encourages the Commission to initiate an overdue rulemaking to address unresolved pole and rights-of-way issues. Such issues include: (1) a clarification of the Commission's rules regarding the allocation of the costs when replacing utility poles to accommodate broadband attachments; (2) addressing the needs of both wireless and wireline providers for truly non-discriminatory access to poles and rights-of-way; and (3) providing expedited resolution of pole access disputes.

The SHLB Coalition mission is to promote open, affordable, high-quality broadband for anchor institutions and their communities. We strongly support the efforts of Congress, the Biden Administration, and the Federal Communications Commission to close the digital divide by promoting widespread broadband deployment and affordable service to all areas of the United States, including by identifying and removing barriers to investment in broadband infrastructure.

The timing of such efforts has become particularly critical. The COVID-19 pandemic has dramatically exacerbated the impact on those communities lacking internet access fast and reliable enough to support education, telehealth, remote learning, and telework, threatening to leave a generation of unconnected Americans behind. Passage of the landmark Infrastructure Investment and Jobs Act will unleash tens of billions of additional public investment in broadband infrastructure to address this

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<sup>1</sup> *SHLB Ex Parte Notice with Pole Attachment Principles to Expedite Broadband Attachments for Anchor Institutions and Their Communities*, WC Docket No. 17-84 (Sept. 2, 2021) (attached).

challenge.<sup>2</sup> This investment will be on top of numerous other federal programs that are already pouring billions of dollars into the deployment of new broadband infrastructure, including (among others) the Coronavirus Capital Projects Fund, state and municipal broadband infrastructure projects under the Coronavirus State and Local Relief Funds authorized by the American Rescue Plan, the National Telecommunications and Information Administration's Broadband Infrastructure Program, Connecting Minority Communities Pilot Program and Tribal Connectivity Program, the Rural Utilities Service's ReConnect program, and the Commission's Rural Digital Opportunities Fund.

This massive and imminent public investment in broadband infrastructure could be a transformational, once-in-a-generation digital divide-closing success story—or it could sputter and fail in the face of the massive practical challenges of bringing these projects to fruition. Its success depends upon a regulatory environment that ensures that construction projects enabled by these programs are not mired in delays and cost overruns that prevent them from realizing their transformational potential.<sup>3</sup>

Unfortunately, the high costs and delays in gaining access to poles and rights-of-way often hinder the ubiquitous broadband deployment that is so urgently needed, and the costs of replacing existing utility pole infrastructure can impede the success of broadband expansion and deployment efforts. Our members have experienced unpredictable pole attachment, make-ready, and permit costs that can range from 20% to 50% of the cost of some broadband deployment projects. In some cases, as shown below, the unpredictability and costs of pole replacements can lead to the cancellation of broadband deployment plans altogether. In other cases, broadband deployment plans are significantly delayed or must be curtailed in order to make the project economically viable.

In particular, SHLB members have seen time and time again that delays and costs arising out of pole attachments and right-of-way access can frustrate otherwise-promising broadband projects. SHLB members include several nonprofit, state-based research and education networks, whose mission is to provide anchor institutions with greater broadband connectivity, as well as some commercial broadband providers.<sup>4</sup> These organizations have identified several examples of how access to poles and rights-of-way can inhibit broadband deployment:

#### **Pole Survey & Replacement Costs:**

- If a pole owner doesn't monitor the load capacity or communication space on a pole, it can fall to new attachers to conduct engineering studies to determine if the infrastructure can support an additional attachment. The Imperial County of Education in California (ICOE) spent \$100,000 for a single project and ultimately had to return awarded grant money due to the condition of the poles and the cost to remediate.

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<sup>2</sup> We note that the Infrastructure Investment and Jobs Act specifically references anchor institutions 29 times, a recognition of the critical role that anchor institutions can play in connecting all Americans to high-speed broadband.

<sup>3</sup> According to one article, former Governor Cuomo's initiative to expand broadband access in upper New York State was stymied by excessive rights-of-way fees and pole attachment fees that made it uneconomic to serve the Adirondack region. See, <https://www.adirondackexplorer.org/stories/a-nest-of-north-country-broadband-issues>.

<sup>4</sup> A full list of SHLB members is located at [www.shlb.org/about/coalition-members](http://www.shlb.org/about/coalition-members).

- In another case in New York state, a small ISP was required to survey the poles and replace several poles at a cost of \$6,000 to \$18,000 per pole, even though the pole would remain owned by the utility.<sup>5</sup>
- Socorro Independent Schools is located in Socorro County, New Mexico, identified as one of the worst connected counties by a recent study. For the last several years, the local school district has been working to secure proposals for scalable broadband infrastructure upgrades for two of their rural schools. More than once, the better connectivity seemed to be within reach due to E-rate and state match funding, only to have the project fall through due to exorbitant pole replacement costs rendering the entire project budget not viable. With years of preparation work being lost, students and the surrounding community will go several more years without the connectivity they need.

#### **Make-ready Costs:**

- In E-Rate funding year 2019, Kalamazoo Regional Educational Service Agency (KRESA) and Allegan Area Educational Service Agency (AAESA) partnered to build a fiber optic wide area network (WAN) to connect the regional agencies and learning communities. Despite a successful procurement process, which leveraged E-Rate discounts and state matching fund dollars, the applicant consortium was not able to overcome a \$600,000 increase in make-ready costs, forcing the cancellation of the build. Consortium members paid out over \$294,000 - nearly equal to state funding generated by 34 students - for costs related to a network that will never serve these students.

#### **Significant Delay:**

- Steamboat Springs School District in Colorado experienced the challenge of a project's construction schedule being significantly delayed by slow response times from an incumbent service provider who owned the poles in the region. The pole owner would repeatedly delay access by waiting until the final day of the legal response window to reply to a pole attachment request and then responded with a question that would restart the response window. Ultimately, the school district had to re-engineer their network to a new route in order to complete the project, incurring significant unforeseen costs.

#### **Access to Rights-of-Way:**

- One broadband company had to obtain 300 permits to use the rights-of-way for a single 12-mile fiber deployment, which delayed the project by over one year.
- UTOPIA (a non-profit open access broadband provider) was forced to file suit against the City of American Fork in Utah because the city canceled a contract to provide access to its rights-of-way. The city denied UTOPIA key permits that would have allowed it to extend services to UTOPIA Fiber customers inside the city, including to the city's public schools.<sup>6</sup>

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<sup>5</sup> See, [https://www.livingstonparishnews.com/opinion/editorials/opinion-regulators-stifle-broadband-expansion-with-exorbitant-pole-attachment-fees/article\\_5b49e3f0-7a24-11eb-b858-6be303598004.html](https://www.livingstonparishnews.com/opinion/editorials/opinion-regulators-stifle-broadband-expansion-with-exorbitant-pole-attachment-fees/article_5b49e3f0-7a24-11eb-b858-6be303598004.html).

<sup>6</sup> <https://broadbandbreakfast.com/2021/10/utopia-fiber-goes-to-court-in-utah-over-american-forks-build-permit-refusals/>.

The Commission can play a critical role in preventing similar fates from befalling the countless new broadband projects that are being funded by the recent infusion of public support. It can do so by helping to ensure that the right regulatory policies are in place as these programs move forward—both by setting policy directly (in areas the Commission itself regulates) and by modeling ideal policies that other regulators, such as state public utilities commissions, can follow in areas under their jurisdiction.<sup>7</sup>

Last September, SHLB submitted to the Commission a proposed set of principles (attached) to guide policies that will help ensure that broadband projects can be completed on time and on budget. One concrete step towards these principles in the short term would be for the Commission to build on its 2017 and 2018 reforms in this docket and further clarify and revise its pole attachment rules, particularly with respect to pole replacements and dispute resolution.

Further reform of the Commission’s rules is needed to provide clarity and ensure that the once-in-a-generation public investment in broadband architecture is not delayed or derailed by pole access disputes. To that end, **SHLB continues to encourage the Commission to initiate a rulemaking to address open issues** and

- (1) evaluate and reform the Commission’s rules regarding the allocation of the costs of replacing utility poles when necessary to accommodate new broadband attachments,
- (2) address the needs of both wireless and wireline providers for non-discriminatory access to poles and rights-of-way, and
- (3) provide expedited resolution of pole access disputes.<sup>8</sup>

There is simply no time to waste. The continued lack of reliable internet access to much of America risks leaving many communities behind, and has serious and harmful economic effects.

Along with our policy leaders, SHLB's members come from different states and viewpoints, but we share a goal to promote ubiquitous, high-capacity broadband networks that are capable of providing our communities and anchor institutions with open, affordable, high-quality broadband for all. We urge the Commission to take prompt action to advance this goal, and SHLB stands ready to assist in any way possible.

Sincerely,



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<sup>7</sup> Lack of clarity around pole policies also harms municipal providers. For instance, some incumbent pole owners have also tried to impose restrictive lease agreements that prevent municipalities from forming partnerships with Internet Service Providers (ISPs). See, <https://muninetworks.org/content/problem-poles-connecticut-petitioning-pura-precision>.

<sup>8</sup> See *Accelerating Wireline Broadband Deployment by Removing Barriers to Infrastructure Investment*, Declaratory Ruling (WCB Jan. 19, 2021), at ¶ 11 (finding that “a rulemaking is a more appropriate forum to more fully address” questions raised by the NCTA petition); NCTA – The Internet & Television Association, *Petition for Expedited Declaratory Ruling* (July. 16, 2020), WC Docket No. 17-84.

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September 2, 2021

Marlene H. Dortch, Secretary  
Federal Communications Commission  
45 L Street, NE  
Washington, D.C. 20554

Re: **SHLB Ex Parte Notice with Pole Attachment Principles to Expedite Broadband Attachments for Anchor Institutions and Their Communities - WC Docket No. 17-84**

Dear Ms. Dortch:

The Schools, Health & Libraries Broadband (SHLB) Coalition<sup>9</sup> is pleased to submit this letter and attached document into the record of the above-referenced proceeding, WC Docket No. 17-84. SHLB strongly supports the Federal Communications Commission's (FCC's) efforts to solve the Digital Divide by promoting widespread broadband deployment and affordable service to all areas of the United States. Unfortunately, the high costs and delays in gaining access to poles often hinder the ubiquitous broadband deployment that is so urgently needed. SHLB observes that the United States has not yet reached Goal #4 in the National Broadband Plan to make gigabit connectivity available to the nation's community anchor institutions. Our members report that the pole attachment and replacement problems – due in part to the lack of clarity around the policies and rules – often deter and delay efforts to upgrade their broadband connections and services for anchor institutions, especially in rural markets.

To address these ambiguities, the SHLB Coalition convened a group of its members to draw up the attached principles to guide pole attachment and replacement policies and procedures going forward.<sup>10</sup> The principles attempt to reflect a balance of interests among state and local governments, pole owners, broadband providers, and anchor institutions. For instance, we recognize that state and local governments have been working to improve their pole attachment practices, but they often lack the resources to handle the increase in pole attachment requests. The principles thus call for additional funding for pole owners to help expedite their pole attachment decision-making and implementation. The principles also call for non-discriminatory treatment of broadband service providers and pole owners to avoid favoring one sector over another. The principles recommend the adoption of just and reasonable rates for pole access that reflect actual costs. The principles also suggest that the costs of

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<sup>9</sup> The Schools, Health & Libraries Broadband (SHLB) Coalition is a non-profit public interest group with about 300 members from around the United States. We support open, affordable, high-quality broadband for anchor institutions and their surrounding communities. More information and a list of our members is available at [www.shlb.org](http://www.shlb.org).

<sup>10</sup> While SHLB Coalition members participated in these discussions, these principles are submitted on behalf of the SHLB Coalition alone and should not be attributed to any of its members. The SHLB Coalition is an independent public interest group and is not a trade association.

pole replacement should be shared equitably among pole owners and attachers. Moreover, the principles encourage process reform in order to expedite the resolution of pole-related complaints and disputes.

The SHLB Coalition respectfully submits these principles and requests that the FCC move forward with a rulemaking proceeding to address these critical gating issues in the near future. As of this writing, Congress is on the verge of enacting significant infrastructure legislation that would appropriate several billion dollars for broadband deployment and to make broadband service more affordable. Clarifying the nation's pole attachment policies – along the lines of the attached principles – could go a long way toward solving the Digital Divide and fulfilling Congressional intent.

Sincerely,

A handwritten signature in black ink that reads "John Windhausen, Jr." The signature is written in a cursive style with a small dot at the end of the last name.

John Windhausen, Jr.  
Executive Director  
Schools, Health & Libraries  
Broadband (SHLB) Coalition  
1250 Connecticut Ave. Suite 700  
Washington, DC 20036

Attachment

cc: Travis Litman



**POLE ATTACHMENT PRINCIPLES  
TO EXPEDITE BROADBAND DEPLOYMENT  
TO ANCHOR INSTITUTIONS AND THEIR COMMUNITIES**

June 28, 2021

The policies governing access to utility poles can have a significant impact on the pace of broadband deployment to unserved and underserved markets. Providing a consistent framework, while recognizing the variety of circumstances that affect local pole attachment costs, can help to streamline the pole attachment process and expedite broadband deployment to anchor institutions and their surrounding communities. The SHLB Coalition urges policy-makers and pole owners to incorporate the following principles into their pole attachment policies.

**1. All Pole Owners Should Be Subject to Comparable Rules Governing Pole Access.**

- All pole owners should be required to offer reasonable rates, terms and conditions for pole access, with the goal of parity between the rules governing investor-owned utilities (IOUs) and those applicable to other pole owners, including cooperatives and municipalities.
- Although the FCC regulates IOUs, many utility poles are owned and operated by other entities, including cooperatives and municipalities, not currently regulated by the FCC.

**2. Electric and Telephone Easements and Public Rights of Way Should Be Made Available for Broadband.**

- In jurisdictions where easements and public rights of way for electric or telephone infrastructure are limited to electric and/or telephone wires, they should be expanded to encompass broadband and communications facilities as well.

**3. Rates, Terms and Conditions for Pole Access Should Be Just, Reasonable, Predictable, and Prompt.**

- State and local governments should use their authority over access to poles to apply the FCC's rules regarding pole access and make-ready for all pole owners -- including IOUs, municipal utilities and cooperatives. FCC rules are well-developed, have received extensive consideration by an expert agency, and have been the subject of input from all stakeholders. This includes "self-help" remedies and "one-touch make-ready" options that allow attachers to proceed promptly and safely without unnecessary delays. State and local governments should be incentivized to implement these FCC rules and policies.

- Timelines and application procedures for accessing poles, including for the completion of make-ready work, should be predictable and prompt and should provide some flexibility. Denials of access must be specific and reasonably based upon safety, reliability, engineering, or capacity considerations.
- If a pole owner requires a written agreement to attach to poles, it should be required to negotiate such agreements in good faith, including updating those agreements to incorporate reforms to pole attachment rules that occur during the contract term.

**4. Pole Attachment Rates, Terms and Conditions Should be Non-discriminatory and Rates Should be Cost-based.**

- Federal, state and local regulators should ensure that pole owners do not use their ownership of key facilities to impede broadband competition.
- In general, pole owners should be required to extend comparable rates, terms and conditions of access to everyone—including those rates, terms and conditions that are provided to their own affiliates, their business partners, and for the purpose of deploying their own networks.
- In general, pole attachment rates should reflect actual costs – non-recurring charges should reflect the actual immediate costs of make-ready work, and recurring rates should reflect a portion of the actual long-term costs of pole installation, maintenance, ownership and replacement.

**5. To support broadband deployment, federal, state and local infrastructure funding should be made available to help defray pole make-ready and pole replacement costs.**

- Funding should be made available to pole owners and broadband providers to help jumpstart the deployment of broadband infrastructure in unserved areas of the country. Such funding will help to reduce the costs associated with broadband deployment, thereby increasing the accessibility and affordability of broadband service.
- Broadband providers should be able to partner with pole owners to leverage infrastructure funding for pole replacements and make-ready in order to expedite broadband deployments.

**6. Pole Capacity Should Be Expanded When Necessary and Costs Should be Shared Fairly**

- Poles that are too short, crowded or not strong enough to support new broadband facilities should be replaced or reinforced so that broadband can be deployed where it is needed.
- Costs for expanded capacity should be shared equitably.
- The cost of replacing older poles should not be borne entirely by new or existing attachers. Imposing the entire pole replacement costs on new or existing attachers unfairly subsidizes the pole owner's plant (as the pole owner would have otherwise been responsible for replacement) and unreasonably drives up the cost of new broadband and communications deployment. Pole owners share in the benefits of pole replacements, particularly by avoiding certain future replacement and maintenance costs, and should contribute to pole replacements accordingly.

- Make ready work for new attachers should not include costs for correcting pre-existing violations of licensors, licensees, or joint users.

**7. Engineering and Safety Requirements Should Be Reasonable and Transparent.**

- Pole owners' safety and engineering standards should be reasonable given local conditions—and should be based upon genuine safety and engineering considerations. Safety and engineering codes should not be used by pole owners as a pretext to force attachers to pay for improvements, or to make it more difficult for attachers to offer competing services.
- Safe temporary attachments and extension arms should be permitted to allow broadband to be extended to unserved areas pending completion of make-ready work on poles.
- Pole owners and providers should coordinate and use third party resources if necessary to expedite the engineering and permitting process.

**8. Overlapping Should Be Permitted Upon Notice, Without Separate Application Requirements.**

- Overlapping—*i.e.*, adding a new attachment to an existing one—helps speed broadband deployment by enabling broadband facilities to be deployed simply and safely, as long as overlapping follows generally accepted safety and engineering standards.

**9. Regulators Should Make Prompt Dispute Resolution Available for Pole Access Disputes.**

- Sensible pole access and attachment rules will only help speed broadband deployment if they are followed and enforced. Disputes must be resolved by regulators quickly.
- Policy-makers should include all stakeholders in the process of developing and implementing pole attachment policies.

**10. Pole Owners Should Keep Sufficient, Timely Records to Calculate Recurring Rates, and Make the Records Available.**

- Sensible rules governing just and reasonable rental charges for poles are only meaningful if pole owners maintain and share the data necessary to calculate those rates fairly and accurately.
- The process of rate calculation should be fair and transparent.

For questions about these Pole Attachment Principles, please contact John Windhausen, Executive Director, SHLB Coalition, at [jwindhausen@shlb.org](mailto:jwindhausen@shlb.org).

# ADVANCING POLE ATTACHMENT POLICIES TO ACCELERATE NATIONAL BROADBAND BUILDOUT

EDWARD J. LOPEZ AND  
PATRICIA D. KRAVTIN



**CONNECT  
THE FUTURE**

## ABOUT THE AUTHORS

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Owner and Principal of Patricia D. Kravtin Economic Consulting, a private consultancy specializing in telecommunications, energy, cable regulation and broadband markets. She is frequently called upon as an expert witness on pole attachment related matters before state, federal, and international regulatory bodies. Ms. Kravtin studied in the Ph.D. program in economics at MIT, with concentrations in Government Regulation of Industry, Industrial Organization, and Urban and Regional Economics.

*This report has been underwritten by Connect The Future. The opinions and viewpoints expressed are those of the authors alone.*

## EXECUTIVE SUMMARY

Between 14 to 42 million Americans currently lack access to high-speed broadband. In this study, we estimate that expanding broadband access to this unserved population would create anywhere from \$83 billion to \$314 billion of new economic gains to America's homes and small businesses. This estimated gain represents the social return on new public and private sector investments, namely the productive, commercial, educational, health, and other benefits that stand to be realized by achieving full broadband expansion in America.

Today, broadband deployment is being inhibited or outright stopped due to the lack of effective pole policy to address problematic behavior of certain utility pole owners affecting broadband provider access to utility poles. Specifically, pole owners frequently deny or delay broadband providers pole attachment access, or impose economically unfeasible rates, terms, and conditions that impose excessive costs on broadband providers associated with pole replacement and upkeep. In economics this is known as the *hold up problem*<sup>1</sup>, an inefficient concentration of *market power* that harms the *public interest*.

When pole owners hold up the process, the result is foregone economic gains to Americans. In this study, we estimate that every month of delayed expansion due to pole owner hold up costs Americans between

\$491 million and \$1.86 billion.

Utility poles represent a critical input in broadband deployment, as attachment to existing pole networks is the most efficient means to expand high-speed broadband access to currently unserved areas of the country. Policymakers should initiate measures now to recapture this economic value by revising and modifying state and federal pole policies to mitigate pole owner *market power* in order to facilitate broadband deployment.

Pole Owner  
Hold Up  
Costs Americans  
**\$491M - \$1.86B**  
*every month*  
it delays expansion.

## INTRODUCTION AND OVERVIEW

**T**oo many American homes and small businesses still lack access to reliable, high-speed, low-latency internet connections. While recent private and public investments at the national, state, and local levels are playing a significant role in helping to bridge America's digital divide, policies to remove remaining barriers to infrastructure deployment are now needed to maximize the social return on public and private broadband investments.<sup>2</sup> In this paper, we demonstrate that the economic gains to full broadband expansion are quite substantial, yet state and federal policies governing pole attachment processes require modification before the digital divide can be fully bridged and those economic gains realized. (See below Appendix A, *Elements of a Model Pole Policy*, for details of these required modifications.)

According to the Federal Communications Commission (FCC), more than 14 million Americans still lack access to reliable, high-speed, low-latency broadband, including nearly 20% of rural households (FCC 2021). An estimate by BroadbandNow suggests that over 42 million Americans still lack access.<sup>3</sup> In this paper, we estimate that connecting these currently unserved populations would create as much as \$314 billion of new economic gains to America's homes and small businesses, calculated as additional willingness-to-pay (WTP) in net present value over 25 years, or the lower end of average utility pole life, at 5% discount rate.<sup>4</sup> This estimated economic gain represents the potential return on private and public broadband investments, namely the

productive, commercial, educational, health, civic, and other social benefits that could be realized by achieving full broadband expansion.

To achieve these economic and social gains requires cost efficient and timely attachment of broadband wires to existing utility pole networks. Deployment of broadband networks into unserved rural areas of the country requires attachment of broadband infrastructure to thousands and thousands of poles. Placement of broadband infrastructure underground isn't feasible or cost efficient in most unserved areas of the country.

Existing pole policies across the country, however, allow electric utility pole owners – i.e., investor-owned electric utilities (“IOUs”), as well as municipal and cooperatively owned utilities (“Muni and Coop”) – to exercise significant market power over pole attachment rates, terms, and conditions. Pole owners frequently impose onerous timetables, unfeasible permitting fees, and various pre- and post-construction requirements, including full pole replacements ahead of scheduled replacement, as part of “make-ready” procedures required prior to the actual attachment to the pole. Pole owners sometimes limit the number of pole-attachment applications considered at any given time, and certain pole owners have refused to consider any applications at all. Furthermore, increasing numbers of Muni and Coop owners have themselves become market participants in providing broadband service (Beard et al. 2021)

In the study of economics, this form of market power is known as the *hold up problem*, and it causes delayed or foregone expansion of broadband to currently unserved populations. This inefficient and inequitable advantage, in the absence of effective pole policies, enables certain pole owners to impose economically unfeasible rates, terms, and conditions that harm the *public interest* by holding up broadband deployment. We estimate that every month of delayed expansion due to pole owner market power costs Americans between \$491 million and \$1.86 billion in foregone economic gain, known in economics as *deadweight loss* (DWL).<sup>5</sup> The economic methodology for this study was initially developed in an earlier paper that focused on North Carolina.<sup>6</sup> That study calculated economic gains that would be realized with full broadband expansion in North Carolina under just one federal program, the Rural Development Opportunity Fund (RDOF), which launched in February, 2020, with a total \$20 billion of rural broadband investment across the country.<sup>7</sup>

The need for a nationwide examination is now all the more relevant given the recent passage of the Infrastructure Investment and Jobs Act of 2021 (“IIJA”) and its massive \$42 billion commitment to broadband buildout across all 50 states. When combined with federal and state funding already in the pipeline as part of the recent COVID-19 relief packages, the government funding commitment to deploy broadband in all 50 states is unprecedented. Therefore, in this study we enhance and expand the analysis beyond North Carolina and the funding being supplied by RDOF. Results in this paper include estimates of

economic gain of full broadband expansion for all 50 States, while also including a more granular analysis for five focus states (Florida, Kentucky, Missouri, Texas, and Wisconsin).

The analysis in this paper concludes that if the economic gains from broadband deployment are to be fully realized, policymakers need to facilitate the streamlining of equitable access and cost-sharing arrangements between broadband attachers and pole owners. These improved arrangements, among others, would factor the age and net book value of replaced poles, thus eliminating a common barrier in which broadband providers are too often inequitably (and contrary to sound economic policy) required by pole owners to bear the full monetary burden of pole replacements ahead of scheduled replacement. These and other key elements of a model pole policy that best promote broadband expansion are presented in Appendix A.

This barrier to full broadband expansion arises because in most instances the only practical and economically feasible means for a broadband provider to connect its service to a household or small business location is to attach its wires to the existing network of utility poles. Building underground is unrealistic given the prohibitively higher costs as compared to aerial installations along with the host of other practical, environmental, and topographical barriers associated with underground construction. And the notion that broadband providers could build their own standalone pole networks would not only be a waste of social resources and aesthetically undesirable, in many if not most instances would be effectively prohibited

under zoning rules, environmental regulations and other laws and ordinances.

## CRITICAL BACKGROUND AND METHODOLOGY

In this paper, we expand and enhance our earlier analysis for North Carolina.<sup>8</sup> First, we expand our calculations beyond RDOF and to all 50 states. Nationally, RDOF auction participants were awarded over \$9 billion to connect 5.22 million locations, or approximately 2 million people.<sup>9</sup> Yet, RDOF is a relatively small program compared to the FCC's estimated 14 million households currently unserved by broadband, and especially small relative to BroadbandNow's estimate of over 42 million unserved, and in the context of the IJJA's \$42 billion commitment to broadband infrastructure. Therefore, in this paper we also report the estimated consumer gains if all FCC and BroadbandNow unserved populations become connected.<sup>10</sup>

Second, our North Carolina study focused only on the benefits of improved bandwidth speeds, whereas in this paper we also account for latency improvements being rolled out under current deployments. Bandwidth speed measures the megabits/gigabits of data that a connection can transmit per second (Mbps). Latency measures the milliseconds (Ms) it takes for a connection to transport a data packet between a user's computer and other servers elsewhere on the network. Greater latency degrades a customer's service quality and broadband experience. Appendix D below explains how economists have estimated consumers' WTP for both speed and latency, and how we use those empirical

estimates in our calculations of aggregate economic gains.

Our underlying computation methodology begins with a representative household's estimated WTP for broadband, as provided by the Liu, Yu-Hsin, Jeffrey Price and Scott Wallsten (2018). Expressed in layman's terms, WTP is the highest price that a representative household would pay to improve from a slow mobile connection to a fixed connection at higher speeds. WTP therefore represents a dollarized measure of the value to that representative household of broadband's productive, commercial, social, educational, entertainment, health, civic and other benefits, to that household. For example, the representative household is willing to pay \$111.08 per month to improve from a Mobile 4/1 Mbps connection at 60-150 Ms latency, to a Fixed 1000/100 Mbps connection at less than 10 Ms.<sup>11</sup>

Next, we aggregate from the household to the societal level by multiplying that monthly WTP by the number of locations becoming connected. In the case of RDOF, for example, if all 5.22 million locations become connected, that would yield an aggregate \$579 million per month of new WTP. Next, we simply annualize the computed monthly gains, and then compute the annualized gains in terms of net present value over 25 years at an assumed 5% discount rate.<sup>12</sup> Tables 1 and 2,

discussed in the next section, present the results utilizing this method.

As explained in full detail in our earlier paper, economic theory classifies utility poles as a textbook example of a *natural monopoly*, meaning that a single network of poles can supply access to all locations in an area at a lower cost to society than two or more sets of poles can. Given the construction of a network of poles, pole attachments are *non-rival in use* to a degree. For these reasons, economic theory stipulates that efficient pricing of pole attachments—including economically feasible make-ready rates, terms, and conditions—promotes full broadband expansion by resolving the *hold up problem*. This is because pricing practices consistent with economic principles create real-world conditions that facilitate the timely access to high-speed, quality broadband services for consumers in

unserved and typically higher-cost and hard-to-reach areas.

On the other hand, the unchecked exercise of market power by pole owners (IOUs, as well as Muni & Coop) enabled by the lack of consistent, efficient pole policies, will continue to impede this important *public interest* goal. This exercise of market power includes the practice of shifting to broadband providers the total cost of new poles, even in cases when pole owners did not otherwise plan to replace poles in their course of operations. Economic theory therefore classifies *hold up problems* as socially harmful concentrations of market power that result in sizeable lost consumer value and reduction in societal welfare, including delayed or denied broadband expansion to unserved communities.

## FINDINGS AND ANALYSIS

TABLE #1:  
ECONOMIC GAINS IF ALL CURRENTLY UNSERVED POPULATION ACHIEVES BROADBAND ACCESS

	All Unserved RDOF Locations Gain Access	All FCC Unserved Population Gains Access	All BroadbandNow Unserved Population Gains Access
150/25 Mbps at <10 Ms	\$82.96B	\$88.71B	\$265.56B
300/100 Mbps at <10 Ms	\$91.90B	\$98.27B	\$294.17B
1000/100 Mbps at <10 Ms	\$98.07B	\$104.87B	\$313.92B

Note: Table entries equal net present value of annualized gains over 25 years at 5% discount rate.

In Tables 1 above and 2 below, we present our main nationwide findings. Table 1 reports aggregate economic gains for three speed and latency thresholds under three sets of assumptions. The selected speed and latency thresholds are comparable to existing broadband service plan offerings rolling out at the time of this writing. The estimates in Table 1 represent a range of possibilities. For example, if all currently unserved locations assigned for deployment under RDOF get connected at 1000/100 Mbps and <10 Ms, this would create \$98.07 billion of new economic gains nationwide. But if all 14 million persons estimated by the FCC that lack broadband get similarly connected, that gain would be \$104.87 billion. And connecting all 42 million unserved persons as estimated by BroadbandNow would yield \$313.92 billion. These calculations are net present value over 25 years, or the lower end of average pole life, at 5% discount rate.

Focusing on Table 2 below, this same computation methodology demonstrates the foregone economic gains, known in economics as *deadweight loss*, due to the pole owner *hold up problem*. As our previous analysis demonstrated, the identified losses in the form of potential foregone consumer value welfare from the delay or unavailability in broadband access, are also quite substantial. As shown in Table 2, aggregated across the fifty states, we compute the magnitude of potential losses to be in the range of \$491 million to \$1.86 billion per month of delay.

In Appendix D below, we present alternative estimates for different sets of assumptions. And in the state-specific modules below, we report the state-specific estimates equivalent to Table 1 and 2 for our five focus states.

TABLE #2:  
**MONTHLY FOREGONE ECONOMIC GAINS (DEADWEIGHT LOSSES)  
 DUE TO POLE ATTACHMENT HOLD UP**

	All RDOF Locations Gain Access	All FCC Estimated Population Gains Access	All BroadbandNow Estimated Population Gains Access
150/25 Mbps at <10 Ms	\$0.491B	\$0.524B	\$1.57B
300/100 Mbps at <10 Ms	\$0.543B	\$0.581B	\$1.74B
1000/100 Mbps at <10 Ms	\$0.579B	\$0.620B	\$1.86B

*Note: Table entries are monthly aggregate foregone economic gains.*

We emphasize that these national and state-specific estimates are conservative in magnitude because the underlying WTP estimates do not reflect higher broadband demand since COVID-19 or the higher broadband speeds scheduled for deployment under ongoing expansion plans. As cited in Lopez and Kravtin 2021, the Broadband Internet Technical Advisory Group reports that upload demand rose by 60% from March to December 2020, and the RDOF program was structured to incentivize deployment at high speeds including 1000 Mbps download (BITAG 2021). For these reasons, the true economic gains nationwide of full broadband expansion are likely exceed the estimates shown in Table 1 above.

The magnitude of total consumer value that could be realized with unimpeded access to utility poles by broadband providers highlights the potential magnitude of the public's return on its broadband investment that would be made possible if policies aimed at the hold up power of pole owners were implemented and the full range of productive, commercial, educational, health, civic, and other social benefits widely associated with full broadband expansion could be achieved. The next section of the paper further explores the policy implications and prescriptions for full broadband expansion introduced in our earlier paper.

## POLICY IMPLICATIONS AND PRESCRIPTIONS

As described in Lopez and Kravtin 2021, there are a number of key reasons for the current disconnect between existing utility pole practices, especially those involving pole replacement as part of the make-ready process, and those aligned with economic principles that best promote the *public interest*. These include the economic reality that pole owners, regardless of whether the pole is actually identified by the utility as needing replacement, enjoy operational, strategic, revenue-enhancing, capital cost, and tax savings benefits from pole replacements.<sup>13</sup>

When attachers such as broadband providers are forced to bear 100% of the cost responsibility of replacing partially depreciated utility poles, it results in fewer or delayed broadband infrastructure investments

and reduced service availability to the great detriment of unserved areas throughout the nation. This practice disincentivizes broadband deployment for attachers and gifts the utility a significant, windfall economic benefit to the detriment of consumers and the broader economy as a whole.

To ensure consumers benefit from broadband services in a timely and equitable manner, and the economy enjoys as much growth and development gains as possible, public policy should expressly prohibit utilities from requiring an attacher to pay the full replacement cost of a prematurely retired pole, and instead adopt regulations that promote a more economically optimal and equitable approach – e.g., by making attachers only responsible for the remaining un-depreciated value of the replaced pole. In

addition, pole owners should be prohibited from exercising hold up power by imposing unreasonable timelines and/or engaging in delay tactics. This approach would avoid the imposition of substantial and unreasonable costs on pole attachers and would ultimately benefit the country's existing—and new—consumers of high-speed broadband services in the form of cost-efficient broadband connectivity.

Pole owners historically have enjoyed unilateral control of most aspects of the make-ready process. Indeed, opportunities exist for pole owners to exert hold up power by raising the expected stream of ongoing

costs incurred by broadband providers through the recurring pole attachment rental rates that pole owners charge attachers—even in jurisdictions that have adopted effective recurring pole rate regulation for cooperative and municipal pole owning utilities such as North Carolina, the subject of our earlier paper, or in Kentucky, one of the states we examine in more detail in our current analysis. For example, pole owners can harm the *public interest* by failing to give proper written notice of recurring pole attachment rate increases, thereby diminishing or entirely precluding the attacher from effectively challenging the increase and the right to a just and reasonable rate.

## CONCLUSION AND KEY TAKEAWAYS

Pole owner behaviors and the set of unjust and unreasonable make-ready rates, terms and conditions imposed on broadband providers create substantial lost economic gains for residents and small businesses, especially those in hard-to-reach rural unserved areas. Allowing these behaviors to go unchecked is contrary to any reasonable notion of the economic *public interest*. As federal and state resources are increasingly used to support broadband expansion into unserved areas, the *public interest* in supporting a cost-efficient and timely pole attachment process is only heightened. Some believe that the fair outcome is to allow pole owners, especially the smaller local ones, to charge broadband providers higher fees for access to a vital input necessary to reach American consumers. However, as demonstrated in the analysis presented here, this is a much more harmful outcome from an

objective overall societal welfare standpoint, because it reduces or delays consumer access to broadband service, resulting in substantial lost value to consumers.

In the context of achieving full broadband access for residents and small businesses in unserved areas, both theoretical economics and common sense align to create a pressing and justified *public interest* case for policy makers to check the *market power* of pole owners by adopting consistent, efficient policies for poles, including fair and equitable policies around make-ready and pole replacement cost sharing.<sup>14</sup> A number of such legislative and regulatory initiatives are underway across the country, but the ability of pole owning utilities to hold up broadband expansion is going largely unchecked. One of the first of such legislative initiatives enacted to date is Texas HB 1505, passed by the Texas

legislature in the spring of this year. The Texas law, further detailed in the Texas chapter of this paper, incorporates a number of the key elements of a model pole policy presented in Appendix A below required to mitigate pole owner impediments to full broadband expansion.

There are always tradeoffs to consider in economics and public policy. Given the pressing need to close the digital divide, there is greater risk to consumers from the current

inefficient make-ready and pole replacement cost allocation practices than there is from enacting rules and policies that may have the byproduct of reducing nominal flows of monies to pole owners. This is especially the case in unserved areas as those customers stand to gain substantially as potential users of high-quality broadband, including the impact of full broadband access on economic growth and job creation throughout all areas of our nation.

## APPENDICES

A. ELEMENTS OF A MODEL POLE POLICY

B. GLOSSARY OF TECHNICAL TERMS

C. LISTS OF WORKS CITED

D. EMPIRICAL METHODOLOGY AND COMPLETE RESULTS:  
BASELINE/ALTERNATIVE ASSUMPTIONS

## APPENDIX A: ELEMENTS OF A MODEL POLE POLICY

Two foundational principles necessary for the success of broadband deployment in unserved areas are: 1) changing the cost equation for the intermediate pole input in order to encourage infrastructure investment in hard-to-reach areas of the country; and 2) the removal of other regulatory or market impediments to the vital pole input that might jeopardize the cost-efficient nature of that infrastructure investment and deployment. These two principles are at the forefront of the effort to achieve full broadband access in unserved rural areas of our country. The first policy priority is being addressed by federal and state programs that seek to support the cost-efficient deployment of broadband in hard to serve areas of the country; however, the second priority requires additional policies, including policies to ensure an economically efficient and fair cost allocation of pole costs that would help to moderate a pole owners' ability to exercise anti-competitive, anti-consumer market power in an otherwise competitive ecosystem.

Key elements of urgently needed broadband deployment promoting policies include:

- Creation of a pole replacement fund or grant program to promote the efficient use of available state and federal infrastructure funding dollars in support of the buildout of utility pole infrastructure into unserved areas, and in conjunction, ensure pole owners provide nondiscriminatory, just and reasonable non-recurring and recurring rates, terms, and conditions of access to broadband providers (consistent with those detailed below);
- Definitions for make-ready related pole replacements that distinguish make-ready pole replacements from those related to the utility's own inevitable electric (or broadband related) infrastructure upgrade costs;
- Terms that require the pole owner to pay the entire cost of pole replacement when due to safety or reliability as a result of normal wear and tear or other natural causes; or the pole has recorded conditions or defects that would reasonably be expected to endanger human life or property and which should be promptly corrected (whether or not officially "red tagged" for replacement);
- Terms that provide for the economically efficient and equitable sharing of costs of pole replacements tied to the age and/or net book value of the utility poles to be replaced that would preclude, as precondition of access, new attachers from having to bear the full cost of replacing aging poles. This would preclude the utility seeking from attachers the full recovery of poles that the utility would have to replace at its own cost in the near future in the absence of the new attachment or overlash;
- Terms that prevent the utility from seeking any cost recovery from attachers associated with pole replacements unrelated to the need to accommodate a new attachment terms that facilitate the efficient use of federal and state grant funding;

- Detailed make-ready related invoices;
- Specify workable time frames for pole permit application, survey timeframes, pre- and post- construction requirements;
- Shorter timelines for make-ready work;
- Longer timelines for assessing new attacher One Touch Make-Ready ("OTMR") requests versus existing attachers whose facilities are slated for OTMR;
- Audit process and costs;
- Reasonable notice-only policy for overloading;
- Terms that preclude as precondition of access prior to overloading, requirement for permitting or fixing of preexisting violations;
- Expedited dispute resolution under the auspices of the state utility commission or through the courts subject to applicable law;
- Charges for non-recurring charges, including pole replacement, must be based on actual, reasonable costs, objectively determined (i.e., based on accepted economic cost allocation criteria); and
- Recurring rental rates set based on the widely used FCC cable rate formula.

## APPENDIX B: GLOSSARY OF TECHNICAL TERMS

Barriers to Entry - “Factors that increase the cost to new firms of entering an industry”  
(Cowen & Tabarrok 2021)

Deadweight Loss - “the reduction in total [consumer] surplus caused by a market distortion or inefficiency” (Cowen & Tabarrok 2021)  
Example: If a household would gain \$100 of WTP, but it remains unconnected because of the hold up problem, then the deadweight loss is equal to the foregone economic gain of \$100.

Economic Efficiency - “Productive efficiency concerns the utilization of resources to achieve the highest possible level of production of a desired mix of goods and services [and] distribution of goods and services in an economy to maximize social welfare.” (Cole & Grossman 2005, p.10)

Hold Up Problem - the use of market power “to extract by a threat to destroy value” that impedes other’s ongoing investments (Cooter & Uhlen 2004, p.271)

Natural Monopoly - “a situation when a single firm can supply the entire market at a lower cost than two or more firms” (Cowen & Tabarrok 2021)

Non-Rival in Use - “when one person’s consumption of the good does not limit another person’s consumption” (Cowen & Tabarrok 2021)

Public Interest - “the efficient quantity is the quantity that maximizes social surplus”  
(Cowen & Tabarrok 2021)

Willingness-to-Pay (WTP) - “the economic value of something is how much someone is willing to pay for it” (Posner 1992, p.12). Also, “the maximum price a consumer will pay for a good; also called the reservation price” (Mateer & Coppock 2020, p.152)  
Example: If a currently unserved household was willing to pay \$100 to improve from a low-quality connection at slow speeds to a high-quality broadband connection at high speeds, then we say that the household values this broadband improvement as much as it values \$100 of other goods & services.

## APPENDIX C: LIST OF WORKS CITED

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## APPENDIX D: EMPIRICAL METHODOLOGY AND COMPLETE RESULTS: BASELINE/ALTERNATIVE ASSUMPTIONS

The estimates presented in this paper are based on the methodology developed in our earlier paper, Lopez and Kravtin 2021. In Appendix B of that earlier paper, we provide full details on the method underlying the computations in this paper, specifically how we calculate economic gains of broadband expansion as aggregate *willingness-to-pay* (WTP), which is a standard textbook measurement tool in economic theory.

Our calculations in this paper begin with a representative household’s monthly WTP for broadband access. The source of our underlying WTP estimates is the peer-reviewed study by Liu, Prince, and Wallsten 2018. The authors employ a discrete choice experimental design to elicit consumers’ responses to various broadband price and plan options. The experimental design collects responses in a survey format that is designed to simulate the myriad of realistic choices and possible combinations of actual, realistic options of household and small business internet plans.

From the survey results, the authors utilize conditional logit maximum likelihood estimation to derive econometric estimates of a typical household’s WTP for broadband access. Specifically, the authors estimate WTP at various speed thresholds and for various improvements in latency. Table D1 below reproduces select estimates from the Liu et al. study. The dollar amounts in this table represent the amount that a representative household is willing to pay for download speed, upload speed, and latency improvements, relative to a Mobile 5/1 connection. Our methodology adapts these estimates from the Liu et al. study to calculate statewide aggregate figures.

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TABLE D1:  
SELECT WILLINGNESS-TO-PAY ESTIMATES FROM LIU,  
PRINCE, AND WALLSTEN

Download Speeds	Estimated WTP for Improvement from 4 Mbps Down
150 Mbps	\$71.37
300 Mbps	\$75.60
1000 Mbps	\$82.59

Upload Speeds	Estimated WTP for Improvement from 1 Mbps Up
25 Mbps	\$18.57
100 Mbps	\$24.46
Latency Improvements	Estimated WTP for Improvement to Less than 10 Ms
From 60-150 Ms	\$4.03

Table D2 below reports our calculations of WTP for three speed thresholds and improvement from 60-150 Ms to less than 10 Ms latency. For example, our calculation of \$93.97 combines the Liu et al. estimated WTP of \$71.37 for 150 Mbps download, plus the separately estimated \$18.57 for 25 Mbps upload speed, plus the separately estimated \$4.03 for improvement to <10 Ms, yielding a combined WTP of \$93.97 = \$71.37 + \$18.57 + \$4.03. The other estimates of monthly WTP in Table D2 below are calculated the same way.

TABLE D2: SPEED AND LATENCY THRESHOLDS UTILIZED IN THIS PAPER		Speeds (download/ upload)	Household Monthly WTP for Improved Speed and Latency	Household Monthly WTP for Improved Speed Only	
		150/25 Mbps	105/25 Mbps	\$93.97	\$89.94
		300/100 Mbps	300/100 Mbps	\$104.09	\$100.06
		1000/100 Mbps	1000/100 Mbps	\$111.08	\$107.05

Continuing from the monthly gains estimates in Table D2, we next multiply by 12 to calculate the annualized estimated gain to a typical household. We then multiply the household annualized gain by the number of locations in a state to arrive at annualized aggregate economic gain for that state. Finally, we calculate the net present value of annualized gains over 25 years at an assumed 5% discount rate. For complete details about this computation methodology, see Appendix B of Lopez and Kravtin 2021.

Converting from population to number of locations requires a further assumption in our FCC and BroadbandNow estimates. Both sources, the FCC and BroadbandNow estimates, are provided in terms of unserved *population*. To convert from population to locations, we use the U.S. Census Bureau’s American Community Survey, average persons per household 2014-2018 (<https://www.indexmundi.com/facts/united-states/quick-facts/all-states/average-household-size#table>).

For example, in Texas the FCC’s estimated unserved population is 1.23 million, and the persons per household is 2.86, yielding a converted number of FCC locations at 430,070 = 1.23 million persons / 2.86 persons per household. Equivalently for the BroadbandNow estimates, in Texas the BroadbandNow estimated unserved population is 4.39 million, yielding an assumed number of BroadbandNow locations at 1,537,349 = 4.39 million persons / 2.86 persons per household. For the RDOF estimates, we simply use the number of locations reported in the 904 auction results.

In Table D3 below, we present aggregate economic gains for three speed thresholds under three sets of assumptions for all 50 states including our five focus states. The selected speeds (measured in megabits of data) and latency thresholds (measured in milliseconds) are comparable to existing broadband service plan offerings rolling out at the time of this writing. The estimates in Table D3 represent a range of possibilities. For example, in Alabama, if all currently unserved locations assigned for deployment under RDOF get connected at 1000/100 Mbps and <10 Ms, this would create \$3.69 billion of new economic gains statewide. But if all currently unserved persons estimated by the FCC to lack broadband get similarly connected, that gain would be \$4.48 billion. And connecting all unserved persons as estimated by BroadbandNow would yield \$8.86 billion. These calculations are net present value over 25 years, or the lower end of average pole life, at 5% discount rate.

TABLE D3:  
**50-STATE ESTIMATES OF STATEWIDE ECONOMIC GAINS (WTP)**

State	Speed and Latency Improvements	If Unserved RDOF Locations Gain Access	If FCC Unserved Population Gains Access	If BroadbandNow Unserved Population Gains Access
Alabama	150/25 Mbps at <10 Ms	\$3.12b	\$3.79b	\$7.50b
	300/100 Mbps at <10 Ms	\$3.46b	\$4.20b	\$8.30b
	1000/100 Mbps at <10 Ms	\$3.69b	\$4.48b	\$8.86b

Alaska	150/25 Mbps at <10 Ms	\$0.00b	\$0.61b	\$1.34b
	300/100 Mbps at <10 Ms	\$0.00b	\$0.68b	\$1.49b
	1000/100 Mbps at <10 Ms	\$0.00b	\$0.72b	\$1.59b
Arizona	150/25 Mbps at <10 Ms	\$3.19b	\$2.38b	\$5.37b
	300/100 Mbps at <10 Ms	\$3.53b	\$2.63b	\$5.95b
	1000/100 Mbps at <10 Ms	\$3.77b	\$2.81b	\$6.35b
Arkansas	150/25 Mbps at <10 Ms	\$2.06b	\$3.39b	\$5.97b
	300/100 Mbps at <10 Ms	\$2.28b	\$3.76b	\$6.61b
	1000/100 Mbps at <10 Ms	\$2.43b	\$4.01b	\$7.06b
California	150/25 Mbps at <10 Ms	\$5.80b	\$3.19b	\$20.88b
	300/100 Mbps at <10 Ms	\$6.42b	\$3.53b	\$23.13b
	1000/100 Mbps at <10 Ms	\$6.85b	\$3.77b	\$24.68b
Colorado	150/25 Mbps at <10 Ms	\$1.21b	\$1.00b	\$4.19b
	300/100 Mbps at <10 Ms	\$1.34b	\$1.11b	\$4.64b
	1000/100 Mbps at <10 Ms	\$1.43b	\$1.18b	\$4.95b
Connecticut	150/25 Mbps at <10 Ms	\$0.05b	\$0.17b	\$2.42b
	300/100 Mbps at <10 Ms	\$0.05b	\$0.19b	\$2.68b
	1000/100 Mbps at <10 Ms	\$0.05b	\$0.20b	\$2.86b
Delaware	150/25 Mbps at <10 Ms	\$0.12b	\$0.14b	\$0.27b
	300/100 Mbps at <10 Ms	\$0.14b	\$0.15b	\$0.30b
	1000/100 Mbps at <10 Ms	\$0.15b	\$0.16b	\$0.32b
Florida	150/25 Mbps at <10 Ms	\$2.25b	\$4.82b	\$14.24b
	300/100 Mbps at <10 Ms	\$2.49b	\$5.34b	\$15.77b
	1000/100 Mbps at <10 Ms	\$2.66b	\$5.69b	\$16.83b
Georgia	150/25 Mbps at <10 Ms	\$2.85b	\$3.84b	\$10.84b
	300/100 Mbps at <10 Ms	\$3.16b	\$4.25b	\$12.01b
	1000/100 Mbps at <10 Ms	\$3.37b	\$4.53b	\$12.81b
Hawaii	150/25 Mbps at <10 Ms	\$0.13b	\$0.16b	\$3.44b
	300/100 Mbps at <10 Ms	\$0.14b	\$0.17b	\$3.81b
	1000/100 Mbps at <10 Ms	\$0.15b	\$0.19b	\$4.07b
Idaho	150/25 Mbps at <10 Ms	\$0.65b	\$0.49b	\$1.51b
	300/100 Mbps at <10 Ms	\$0.72b	\$0.55b	\$1.68b
	1000/100 Mbps at <10 Ms	\$0.76b	\$0.58b	\$1.79b
Illinois	150/25 Mbps at <10 Ms	\$2.54b	\$1.59b	\$7.53b
	300/100 Mbps at <10 Ms	\$2.82b	\$1.76b	\$8.34b
	1000/100 Mbps at <10 Ms	\$3.01b	\$1.88b	\$8.90b
Indiana	150/25 Mbps at <10 Ms	\$2.43b	\$1.64b	\$5.59b
	300/100 Mbps at <10 Ms	\$2.69b	\$1.82b	\$6.19b
	1000/100 Mbps at <10 Ms	\$2.87b	\$1.94b	\$6.61b
Iowa	150/25 Mbps at <10 Ms	\$0.86b	\$0.84b	\$2.55b
	300/100 Mbps at <10 Ms	\$0.95b	\$0.93b	\$2.83b
	1000/100 Mbps at <10 Ms	\$1.01b	\$0.99b	\$3.02b
Kansas	150/25 Mbps at <10 Ms	\$0.74b	\$0.79b	\$2.16b

	300/100 Mbps at <10 Ms	\$0.82b	\$0.87b	\$2.39b
	1000/100 Mbps at <10 Ms	\$0.88b	\$0.93b	\$2.55b
Kentucky	150/25 Mbps at <10 Ms	\$1.57b	\$1.64b	\$5.31b
	300/100 Mbps at <10 Ms	\$1.74b	\$1.82b	\$5.89b
	1000/100 Mbps at <10 Ms	\$1.85b	\$1.94b	\$6.28b
Louisiana	150/25 Mbps at <10 Ms	\$2.79b	\$3.28b	\$7.02b
	300/100 Mbps at <10 Ms	\$3.09b	\$3.63b	\$7.78b
	1000/100 Mbps at <10 Ms	\$3.30b	\$3.87b	\$8.30b
Maine	150/25 Mbps at <10 Ms	\$0.44b	\$0.31b	\$2.03b
	300/100 Mbps at <10 Ms	\$0.49b	\$0.35b	\$2.25b
	1000/100 Mbps at <10 Ms	\$0.52b	\$0.37b	\$2.40b
Maryland	150/25 Mbps at <10 Ms	\$0.60b	\$0.90b	\$1.33b
	300/100 Mbps at <10 Ms	\$0.66b	\$1.00b	\$1.47b
	1000/100 Mbps at <10 Ms	\$0.71b	\$1.07b	\$1.57b
Massachusetts	150/25 Mbps at <10 Ms	\$0.40b	\$0.88b	\$1.12b
	300/100 Mbps at <10 Ms	\$0.45b	\$0.97b	\$1.25b
	1000/100 Mbps at <10 Ms	\$0.48b	\$1.04b	\$1.33b
Michigan	150/25 Mbps at <10 Ms	\$3.96b	\$2.69b	\$8.41b
	300/100 Mbps at <10 Ms	\$4.39b	\$2.98b	\$9.32b
	1000/100 Mbps at <10 Ms	\$4.68b	\$3.18b	\$9.94b
Minnesota	150/25 Mbps at <10 Ms	\$2.27b	\$0.89b	\$5.62b
	300/100 Mbps at <10 Ms	\$2.51b	\$0.98b	\$6.22b
	1000/100 Mbps at <10 Ms	\$2.68b	\$1.05b	\$6.64b
Mississippi	150/25 Mbps at <10 Ms	\$3.48b	\$3.56b	\$7.13b
	300/100 Mbps at <10 Ms	\$3.86b	\$3.94b	\$7.90b
	1000/100 Mbps at <10 Ms	\$4.11b	\$4.21b	\$8.43b
Missouri	150/25 Mbps at <10 Ms	\$3.16b	\$2.72b	\$6.81b
	300/100 Mbps at <10 Ms	\$3.51b	\$3.01b	\$7.54b
	1000/100 Mbps at <10 Ms	\$3.74b	\$3.21b	\$8.05b
Montana	150/25 Mbps at <10 Ms	\$0.73b	\$0.94b	\$1.72b
	300/100 Mbps at <10 Ms	\$0.81b	\$1.05b	\$1.91b
	1000/100 Mbps at <10 Ms	\$0.86b	\$1.12b	\$2.03b
Nebraska	150/25 Mbps at <10 Ms	\$0.69b	\$0.46b	\$1.19b
	300/100 Mbps at <10 Ms	\$0.76b	\$0.51b	\$1.32b
	1000/100 Mbps at <10 Ms	\$0.82b	\$0.54b	\$1.41b
Nevada	150/25 Mbps at <10 Ms	\$0.49b	\$0.52b	\$0.83b
	300/100 Mbps at <10 Ms	\$0.54b	\$0.58b	\$0.91b
	1000/100 Mbps at <10 Ms	\$0.57b	\$0.62b	\$0.98b
New Hampshire	150/25 Mbps at <10 Ms	\$0.28b	\$0.28b	\$1.60b
	300/100 Mbps at <10 Ms	\$0.31b	\$0.31b	\$1.77b
	1000/100 Mbps at <10 Ms	\$0.33b	\$0.34b	\$1.89b
New Jersey	150/25 Mbps at <10 Ms	\$0.14b	\$0.76b	\$2.42b

	300/100 Mbps at <10 Ms	\$0.15b	\$0.84b	\$2.69b
	1000/100 Mbps at <10 Ms	\$0.16b	\$0.89b	\$2.87b
New Mexico	150/25 Mbps at <10 Ms	\$1.02b	\$1.63b	\$2.90b
	300/100 Mbps at <10 Ms	\$1.13b	\$1.80b	\$3.22b
	1000/100 Mbps at <10 Ms	\$1.21b	\$1.92b	\$3.43b
New York	150/25 Mbps at <10 Ms	\$0.74b	\$1.53b	\$7.69b
	300/100 Mbps at <10 Ms	\$0.82b	\$1.69b	\$8.52b
	1000/100 Mbps at <10 Ms	\$0.88b	\$1.81b	\$9.09b
North Carolina	150/25 Mbps at <10 Ms	\$2.47b	\$2.98b	\$9.88b
	300/100 Mbps at <10 Ms	\$2.73b	\$3.30b	\$10.95b
	1000/100 Mbps at <10 Ms	\$2.91b	\$3.52b	\$11.68b
North Dakota	150/25 Mbps at <10 Ms	\$0.04b	\$0.17b	\$0.84b
	300/100 Mbps at <10 Ms	\$0.05b	\$0.18b	\$0.93b
	1000/100 Mbps at <10 Ms	\$0.05b	\$0.20b	\$1.00b
Ohio	150/25 Mbps at <10 Ms	\$3.04b	\$2.14b	\$9.19b
	300/100 Mbps at <10 Ms	\$3.36b	\$2.38b	\$10.17b
	1000/100 Mbps at <10 Ms	\$3.59b	\$2.54b	\$10.87b
Oklahoma	150/25 Mbps at <10 Ms	\$2.00b	\$2.96b	\$5.74b
	300/100 Mbps at <10 Ms	\$2.22b	\$3.28b	\$6.36b
	1000/100 Mbps at <10 Ms	\$2.37b	\$3.50b	\$6.79b
Oregon	150/25 Mbps at <10 Ms	\$1.30b	\$1.37b	\$4.35b
	300/100 Mbps at <10 Ms	\$1.44b	\$1.51b	\$4.82b
	1000/100 Mbps at <10 Ms	\$1.53b	\$1.62b	\$5.14b
Pennsylvania	150/25 Mbps at <10 Ms	\$2.93b	\$3.39b	\$7.91b
	300/100 Mbps at <10 Ms	\$3.25b	\$3.76b	\$8.76b
	1000/100 Mbps at <10 Ms	\$3.47b	\$4.01b	\$9.35b
Rhode Island	150/25 Mbps at <10 Ms	\$0.06b	\$0.10b	\$0.21b
	300/100 Mbps at <10 Ms	\$0.06b	\$0.11b	\$0.23b
	1000/100 Mbps at <10 Ms	\$0.07b	\$0.11b	\$0.25b
South Carolina	150/25 Mbps at <10 Ms	\$1.73b	\$2.82b	\$7.46b
	300/100 Mbps at <10 Ms	\$1.92b	\$3.13b	\$8.27b
	1000/100 Mbps at <10 Ms	\$2.04b	\$3.34b	\$8.82b
South Dakota	150/25 Mbps at <10 Ms	\$0.16b	\$0.29b	\$0.94b
	300/100 Mbps at <10 Ms	\$0.18b	\$0.33b	\$1.04b
	1000/100 Mbps at <10 Ms	\$0.19b	\$0.35b	\$1.11b
Tennessee	150/25 Mbps at <10 Ms	\$2.47b	\$2.72b	\$7.98b
	300/100 Mbps at <10 Ms	\$2.73b	\$3.01b	\$8.84b
	1000/100 Mbps at <10 Ms	\$2.92b	\$3.22b	\$9.43b
Texas	150/25 Mbps at <10 Ms	\$4.94b	\$6.84b	\$24.43b
	300/100 Mbps at <10 Ms	\$5.47b	\$7.57b	\$27.06b
	1000/100 Mbps at <10 Ms	\$5.84b	\$8.08b	\$28.88b
Utah	150/25 Mbps at <10 Ms	\$0.16b	\$0.70b	\$1.12b
	300/100 Mbps at <10 Ms	\$0.18b	\$0.78b	\$1.25b

	1000/100 Mbps at <10 Ms	\$0.19b	\$0.83b	\$1.33b
Vermont	150/25 Mbps at <10 Ms	\$2.96b	\$0.26b	\$1.11b
	300/100 Mbps at <10 Ms	\$3.28b	\$0.29b	\$1.23b
	1000/100 Mbps at <10 Ms	\$3.50b	\$0.31b	\$1.31b
Virginia	150/25 Mbps at <10 Ms	\$0.31b	\$3.43b	\$6.44b
	300/100 Mbps at <10 Ms	\$0.34b	\$3.80b	\$7.13b
	1000/100 Mbps at <10 Ms	\$0.36b	\$4.05b	\$7.61b
Washington	150/25 Mbps at <10 Ms	\$1.60b	\$1.76b	\$8.01b
	300/100 Mbps at <10 Ms	\$1.77b	\$1.95b	\$8.87b
	1000/100 Mbps at <10 Ms	\$1.89b	\$2.08b	\$9.47b
West Virginia	150/25 Mbps at <10 Ms	\$1.90b	\$2.09b	\$5.91b
	300/100 Mbps at <10 Ms	\$2.10b	\$2.32b	\$6.55b
	1000/100 Mbps at <10 Ms	\$2.24b	\$2.48b	\$6.99b
Wisconsin	150/25 Mbps at <10 Ms	\$3.82b	\$2.61b	\$4.44b
	300/100 Mbps at <10 Ms	\$4.23b	\$2.89b	\$4.92b
	1000/100 Mbps at <10 Ms	\$4.52b	\$3.08b	\$5.25b
Wyoming	150/25 Mbps at <10 Ms	\$0.30b	\$0.27b	\$0.65b
	300/100 Mbps at <10 Ms	\$0.33b	\$0.30b	\$0.72b
	1000/100 Mbps at <10 Ms	\$0.36b	\$0.32b	\$0.77b

Moving to Table D4 below, this same computation methodology demonstrates the foregone economic gains, known in economics as *deadweight loss*, due to delayed or denied broadband expansion under the pole owner *hold up problem*. As our analysis in Lopez and Kravtin 2021 demonstrated, the identified losses in the form of potential foregone consumer value welfare from the delay or unavailability in broadband access, are also quite substantial. In Alabama, for example, each month of delayed expansion causes DWL in the range of \$18.46 million to \$52.40, per month, under alternative assumptions.

TABLE D4:  
50-STATE ESTIMATES OF FOREGONE ECONOMIC GAINS (DWL)  
DUE TO POLE ATTACHMENT HOLD UP

State	Speed and Latency Improvements	RDOF Locations Delay Cost Per Month	FCC Unserved Population Delay Cost Per Month	BroadbandNow Unserved Population Delay Cost Per Month
Alabama	150/25 Mbps at <10 Ms	\$18.46m	\$22.41m	\$44.33m
	300/100 Mbps at <10 Ms	\$20.45m	\$24.82m	\$49.11m

	1000/100 Mbps at <10 Ms	\$21.82m	\$26.48m	\$52.40m
Alaska	150/25 Mbps at <10 Ms	\$0.00m	\$3.61m	\$7.94m
	300/100 Mbps at <10 Ms	\$0.00m	\$4.00m	\$8.80m
	1000/100 Mbps at <10 Ms	\$0.00m	\$4.27m	\$9.39m
Arizona	150/25 Mbps at <10 Ms	\$18.85m	\$14.06m	\$31.77m
	300/100 Mbps at <10 Ms	\$20.88m	\$15.57m	\$35.19m
	1000/100 Mbps at <10 Ms	\$22.28m	\$16.62m	\$37.55m
Arkansas	150/25 Mbps at <10 Ms	\$12.16m	\$20.05m	\$35.30m
	300/100 Mbps at <10 Ms	\$13.47m	\$22.21m	\$39.11m
	1000/100 Mbps at <10 Ms	\$14.38m	\$23.70m	\$41.73m
California	150/25 Mbps at <10 Ms	\$34.29m	\$18.86m	\$123.44m
	300/100 Mbps at <10 Ms	\$37.98m	\$20.89m	\$136.73m
	1000/100 Mbps at <10 Ms	\$40.53m	\$22.29m	\$145.91m
Colorado	150/25 Mbps at <10 Ms	\$7.16m	\$5.91m	\$24.76m
	300/100 Mbps at <10 Ms	\$7.93m	\$6.55m	\$27.42m
	1000/100 Mbps at <10 Ms	\$8.47m	\$6.99m	\$29.26m
Connecticut	150/25 Mbps at <10 Ms	\$0.27m	\$1.00m	\$14.31m
	300/100 Mbps at <10 Ms	\$0.30m	\$1.11m	\$15.85m
	1000/100 Mbps at <10 Ms	\$0.32m	\$1.18m	\$16.92m
Delaware	150/25 Mbps at <10 Ms	\$0.73m	\$0.80m	\$1.59m
	300/100 Mbps at <10 Ms	\$0.81m	\$0.89m	\$1.76m
	1000/100 Mbps at <10 Ms	\$0.86m	\$0.95m	\$1.88m
Florida	150/25 Mbps at <10 Ms	\$13.31m	\$28.51m	\$84.18m
	300/100 Mbps at <10 Ms	\$14.74m	\$31.58m	\$93.25m
	1000/100 Mbps at <10 Ms	\$15.73m	\$33.70m	\$99.51m
Georgia	150/25 Mbps at <10 Ms	\$16.86m	\$22.68m	\$64.09m
	300/100 Mbps at <10 Ms	\$18.68m	\$25.12m	\$71.00m
	1000/100 Mbps at <10 Ms	\$19.93m	\$26.81m	\$75.76m
Hawaii	150/25 Mbps at <10 Ms	\$0.76m	\$0.93m	\$20.36m
	300/100 Mbps at <10 Ms	\$0.84m	\$1.03m	\$22.56m
	1000/100 Mbps at <10 Ms	\$0.90m	\$1.10m	\$24.07m
Idaho	150/25 Mbps at <10 Ms	\$3.83m	\$2.91m	\$8.95m
	300/100 Mbps at <10 Ms	\$4.24m	\$3.22m	\$9.92m
	1000/100 Mbps at <10 Ms	\$4.52m	\$3.44m	\$10.58m
Illinois	150/25 Mbps at <10 Ms	\$15.03m	\$9.40m	\$44.51m
	300/100 Mbps at <10 Ms	\$16.65m	\$10.41m	\$49.30m
	1000/100 Mbps at <10 Ms	\$17.77m	\$11.11m	\$52.61m
Indiana	150/25 Mbps at <10 Ms	\$14.38m	\$9.69m	\$33.06m
	300/100 Mbps at <10 Ms	\$15.92m	\$10.74m	\$36.62m
	1000/100 Mbps at <10 Ms	\$16.99m	\$11.46m	\$39.08m
Iowa	150/25 Mbps at <10 Ms	\$5.06m	\$4.95m	\$15.10m
	300/100 Mbps at <10 Ms	\$5.60m	\$5.49m	\$16.73m
	1000/100 Mbps at <10 Ms	\$5.98m	\$5.85m	\$17.85m

Kansas	150/25 Mbps at <10 Ms	\$4.40m	\$4.66m	\$12.75m
	300/100 Mbps at <10 Ms	\$4.87m	\$5.16m	\$14.12m
	1000/100 Mbps at <10 Ms	\$5.20m	\$5.51m	\$15.07m
Kentucky	150/25 Mbps at <10 Ms	\$9.29m	\$16.05m	\$31.43m
	300/100 Mbps at <10 Ms	\$10.29m	\$17.78m	\$34.81m
	1000/100 Mbps at <10 Ms	\$10.98m	\$18.98m	\$37.15m
Louisiana	150/25 Mbps at <10 Ms	\$16.51m	\$19.37m	\$41.50m
	300/100 Mbps at <10 Ms	\$18.29m	\$21.46m	\$45.97m
	1000/100 Mbps at <10 Ms	\$19.52m	\$22.90m	\$49.06m
Maine	150/25 Mbps at <10 Ms	\$2.61m	\$1.86m	\$12.00m
	300/100 Mbps at <10 Ms	\$2.89m	\$2.05m	\$13.29m
	1000/100 Mbps at <10 Ms	\$3.08m	\$2.19m	\$14.19m
Maryland	150/25 Mbps at <10 Ms	\$3.55m	\$5.35m	\$7.85m
	300/100 Mbps at <10 Ms	\$3.93m	\$5.93m	\$8.69m
	1000/100 Mbps at <10 Ms	\$4.19m	\$6.32m	\$9.27m
Massachusetts	150/25 Mbps at <10 Ms	\$2.39m	\$5.20m	\$6.65m
	300/100 Mbps at <10 Ms	\$2.65m	\$5.76m	\$7.37m
	1000/100 Mbps at <10 Ms	\$2.83m	\$6.15m	\$7.86m
Michigan	150/25 Mbps at <10 Ms	\$23.42m	\$15.89m	\$49.73m
	300/100 Mbps at <10 Ms	\$25.95m	\$17.60m	\$55.09m
	1000/100 Mbps at <10 Ms	\$27.69m	\$18.78m	\$58.79m
Minnesota	150/25 Mbps at <10 Ms	\$13.42m	\$5.25m	\$33.21m
	300/100 Mbps at <10 Ms	\$14.87m	\$5.81m	\$36.79m
	1000/100 Mbps at <10 Ms	\$15.87m	\$6.20m	\$39.26m
Mississippi	150/25 Mbps at <10 Ms	\$20.58m	\$21.05m	\$42.17m
	300/100 Mbps at <10 Ms	\$22.79m	\$23.32m	\$46.71m
	1000/100 Mbps at <10 Ms	\$24.33m	\$24.89m	\$49.84m
Missouri	150/25 Mbps at <10 Ms	\$18.72m	\$16.05m	\$40.26m
	300/100 Mbps at <10 Ms	\$20.73m	\$17.78m	\$44.59m
	1000/100 Mbps at <10 Ms	\$22.13m	\$18.98m	\$47.59m
Montana	150/25 Mbps at <10 Ms	\$4.32m	\$5.58m	\$10.18m
	300/100 Mbps at <10 Ms	\$4.79m	\$6.18m	\$11.27m
	1000/100 Mbps at <10 Ms	\$5.11m	\$6.60m	\$12.03m
Nebraska	150/25 Mbps at <10 Ms	\$4.08m	\$2.71m	\$7.05m
	300/100 Mbps at <10 Ms	\$4.52m	\$3.00m	\$7.81m
	1000/100 Mbps at <10 Ms	\$4.82m	\$3.21m	\$8.34m
Nevada	150/25 Mbps at <10 Ms	\$2.87m	\$3.09m	\$4.88m
	300/100 Mbps at <10 Ms	\$3.18m	\$3.42m	\$5.41m
	1000/100 Mbps at <10 Ms	\$3.40m	\$3.65m	\$5.77m
New Hampshire	150/25 Mbps at <10 Ms	\$1.67m	\$1.68m	\$9.44m
	300/100 Mbps at <10 Ms	\$1.85m	\$1.86m	\$10.45m
	1000/100 Mbps at <10 Ms	\$1.97m	\$1.99m	\$11.15m

New Jersey	150/25 Mbps at <10 Ms	\$0.82m	\$4.47m	\$14.34m
	300/100 Mbps at <10 Ms	\$0.90m	\$4.95m	\$15.88m
	1000/100 Mbps at <10 Ms	\$0.96m	\$5.29m	\$16.95m
New Mexico	150/25 Mbps at <10 Ms	\$6.03m	\$9.61m	\$17.17m
	300/100 Mbps at <10 Ms	\$6.68m	\$10.65m	\$19.02m
	1000/100 Mbps at <10 Ms	\$7.13m	\$11.36m	\$20.30m
New York	150/25 Mbps at <10 Ms	\$4.38m	\$9.04m	\$45.49m
	300/100 Mbps at <10 Ms	\$4.86m	\$10.01m	\$50.39m
	1000/100 Mbps at <10 Ms	\$5.18m	\$10.68m	\$53.77m
North Carolina	150/25 Mbps at <10 Ms	\$14.58m	\$17.60m	\$58.44m
	300/100 Mbps at <10 Ms	\$16.15m	\$19.50m	\$64.73m
	1000/100 Mbps at <10 Ms	\$17.23m	\$20.81m	\$69.08m
North Dakota	150/25 Mbps at <10 Ms	\$0.26m	\$0.98m	\$4.99m
	300/100 Mbps at <10 Ms	\$0.29m	\$1.08m	\$5.52m
	1000/100 Mbps at <10 Ms	\$0.31m	\$1.15m	\$5.89m
Ohio	150/25 Mbps at <10 Ms	\$17.96m	\$12.68m	\$54.31m
	300/100 Mbps at <10 Ms	\$19.89m	\$14.05m	\$60.16m
	1000/100 Mbps at <10 Ms	\$21.23m	\$14.99m	\$64.20m
Oklahoma	150/25 Mbps at <10 Ms	\$11.85m	\$17.52m	\$33.94m
	300/100 Mbps at <10 Ms	\$13.13m	\$19.41m	\$37.59m
	1000/100 Mbps at <10 Ms	\$14.01m	\$20.71m	\$40.12m
Oregon	150/25 Mbps at <10 Ms	\$7.67m	\$8.09m	\$25.71m
	300/100 Mbps at <10 Ms	\$8.50m	\$8.96m	\$28.48m
	1000/100 Mbps at <10 Ms	\$9.07m	\$9.56m	\$30.40m
Pennsylvania	150/25 Mbps at <10 Ms	\$17.34m	\$20.05m	\$46.77m
	300/100 Mbps at <10 Ms	\$19.21m	\$22.21m	\$51.80m
	1000/100 Mbps at <10 Ms	\$20.49m	\$23.71m	\$55.28m
Rhode Island	150/25 Mbps at <10 Ms	\$0.35m	\$0.57m	\$1.23m
	300/100 Mbps at <10 Ms	\$0.38m	\$0.63m	\$1.37m
	1000/100 Mbps at <10 Ms	\$0.41m	\$0.67m	\$1.46m
South Carolina	150/25 Mbps at <10 Ms	\$10.23m	\$16.69m	\$44.13m
	300/100 Mbps at <10 Ms	\$11.33m	\$18.48m	\$48.88m
	1000/100 Mbps at <10 Ms	\$12.09m	\$19.72m	\$52.16m
South Dakota	150/25 Mbps at <10 Ms	\$0.94m	\$1.74m	\$5.53m
	300/100 Mbps at <10 Ms	\$1.05m	\$1.93m	\$6.13m
	1000/100 Mbps at <10 Ms	\$1.12m	\$2.06m	\$6.54m
Tennessee	150/25 Mbps at <10 Ms	\$14.59m	\$16.08m	\$47.19m
	300/100 Mbps at <10 Ms	\$16.16m	\$17.81m	\$52.27m
	1000/100 Mbps at <10 Ms	\$17.24m	\$19.01m	\$55.78m
Texas	150/25 Mbps at <10 Ms	\$29.22m	\$40.41m	\$144.46m
	300/100 Mbps at <10 Ms	\$32.37m	\$44.76m	\$160.02m
	1000/100 Mbps at <10 Ms	\$34.54m	\$47.78m	\$170.77m
Utah	150/25 Mbps at <10 Ms	\$0.97m	\$4.14m	\$6.65m

	300/100 Mbps at <10 Ms	\$1.08m	\$4.59m	\$7.36m
	1000/100 Mbps at <10 Ms	\$1.15m	\$4.90m	\$7.86m
Vermont	150/25 Mbps at <10 Ms	\$17.52m	\$1.55m	\$6.55m
	300/100 Mbps at <10 Ms	\$19.41m	\$1.71m	\$7.26m
	1000/100 Mbps at <10 Ms	\$20.71m	\$1.83m	\$7.75m
Virginia	150/25 Mbps at <10 Ms	\$1.82m	\$20.26m	\$38.08m
	300/100 Mbps at <10 Ms	\$2.01m	\$22.44m	\$42.19m
	1000/100 Mbps at <10 Ms	\$2.15m	\$23.95m	\$45.02m
Washington	150/25 Mbps at <10 Ms	\$9.44m	\$10.43m	\$47.36m
	300/100 Mbps at <10 Ms	\$10.45m	\$11.55m	\$52.46m
	1000/100 Mbps at <10 Ms	\$11.15m	\$12.33m	\$55.98m
West Virginia	150/25 Mbps at <10 Ms	\$11.21m	\$12.39m	\$34.95m
	300/100 Mbps at <10 Ms	\$12.41m	\$13.72m	\$38.71m
	1000/100 Mbps at <10 Ms	\$13.25m	\$14.64m	\$41.31m
Wisconsin	150/25 Mbps at <10 Ms	\$22.60m	\$15.43m	\$26.25m
	300/100 Mbps at <10 Ms	\$25.04m	\$17.08m	\$29.08m
	1000/100 Mbps at <10 Ms	\$26.72m	\$18.24m	\$31.04m
Wyoming	150/25 Mbps at <10 Ms	\$1.78m	\$1.60m	\$3.87m
	300/100 Mbps at <10 Ms	\$1.97m	\$1.78m	\$4.28m
	1000/100 Mbps at <10 Ms	\$2.11m	\$1.90m	\$4.57m

Finally, in Tables D5 through D9 below, we present our main findings for the five focus states under alternative assumptions. First, we consider the magnitude of economic gains (WTP) and losses (DWL) without latency improvements. These estimates appear in Tables D5 through D9 in parentheses and correspond to the estimates and assumptions made in our earlier study, Lopez and Kravtin 2021. We also consider a more conservative set of estimates, appearing in brackets, that assume only 60% deployment. As Tables D5 through D9 show, even if only 60% of currently unserved locations are connected, the economic gains are still quite substantial, ranging from \$1.35 to \$10.09 billion in Florida alone, for example. Likewise, the delay costs remain substantial even under the 60% deployment assumption.

TABLE D5:  
**FLORIDA ESTIMATES UNDER ALTERNATIVE ASSUMPTIONS**

Economic Gains	If Unserved RDOF Locations Gain Access	If FCC Unserved Population Gains Access	If BroadbandNow Unserved Population Gains Access
	\$2.25b	\$4.82b	\$14.24b
150/25 Mbps	(\$2.15b)	(\$4.62b)	(\$13.62b)
	[\$1.35b]	[\$2.89b]	[\$8.54b]
	\$2.49b	\$5.34b	\$15.77b
300/100 Mbps	(\$2.39b)	(\$5.13b)	(\$15.16b)
	[\$1.49b]	[\$3.20b]	[\$9.46b]
	\$2.66b	\$5.69b	\$16.83b
1000/100 Mbps	(\$2.56b)	(\$5.49b)	(\$16.22b)
	[\$1.59b]	[\$3.41b]	[\$10.09b]
Foregone Gains	RDOF Locations Delay Cost Per Month	FCC Unserved Population Delay Cost Per Month	BroadbandNow Unserved Population Delay Cost Per Month
	\$13.31m	\$28.51m	\$84.18m
150/25 Mbps	(\$12.73m)	(\$27.29m)	(\$80.57m)
	\$14.74m	\$31.58m	\$93.25m
300/100 Mbps	(\$14.17m)	(\$30.36m)	(\$89.68m)
	\$15.73m	\$33.70m	\$99.51m
1000/100 Mbps	(\$15.16m)	(\$32.48m)	(\$95.89m)

Notes: Economic gains equal aggregate WTP for improvement from a Mobile 5/1 Mbps connection to the listed fixed wireline speeds. Top line entries also include latency improvement from 60-100 Ms to <10 Ms. For comparison purposes, second line entries in (parentheses) exclude latency improvements. Finally, entries in [brackets] assume only 60% of the unserved population gets connected.

TABLE D6:  
**KENTUCKY ESTIMATES UNDER ALTERNATIVE ASSUMPTIONS**

Economic Gains	If Unserved RDOF Locations Gain Access	If FCC Unserved Population Gains Access	If BroadbandNow Unserved Population Gains Access
	\$1.57b	\$1.64b	\$5.31b
150/25 Mbps	(\$1.50b)	(\$1.57b)	(\$5.08b)
	[\$0.94b]	[\$0.98b]	[\$3.19b]
	\$1.74b	\$1.82b	\$5.89b
300/100 Mbps	(\$1.67b)	(\$1.74b)	(\$5.66b)
	[\$1.04b]	[\$1.09b]	[\$3.53b]
	\$1.85b	\$1.94b	\$6.28b
1000/100 Mbps	(\$1.79b)	(\$1.86b)	(\$6.06b)
	[\$1.11b]	[\$1.16b]	[\$3.77b]
Foregone Gains	RDOF Locations Delay Cost Per Month	FCC Unserved Population Delay Cost Per Month	BroadbandNow Unserved Population Delay Cost Per Month
	\$9.29m	\$16.05m	\$31.43m
150/25 Mbps	(\$8.89m)	(\$9.28m)	(\$30.08m)
	\$10.29m	\$17.78m	\$34.81m
300/100 Mbps	(\$9.89m)	(\$10.32m)	(\$33.46m)
	\$10.98m	\$18.98m	\$37.15m
1000/100 Mbps	(\$10.58m)	(\$11.05m)	(\$35.80m)

Notes: See Table D5 notes above.

TABLE D7:  
MISSOURI ESTIMATES UNDER ALTERNATIVE ASSUMPTIONS

Economic Gains	If Unserved RDOF Locations Gain Access	If FCC Unserved Population Gains Access	If BroadbandNow Unserved Population Gains Access
	\$3.16b	\$2.72b	\$6.81b
150/25 Mbps	(\$3.03b)	(\$2.59b)	(\$6.52b)
	[\$1.89b]	[\$1.63b]	[\$4.09b]
	\$3.51b	\$3.01b	\$7.54b
300/100 Mbps	(\$3.37b)	(\$2.89b)	(\$7.25b)
	[\$2.11b]	[\$1.81b]	[\$4.52b]
	\$3.74b	\$3.21b	\$8.05b
1000/100 Mbps	(\$3.61b)	(\$3.09b)	(\$7.76b)
	[\$2.24b]	[\$1.93b]	[\$4.83b]
Foregone Gains	RDOF Locations Delay Cost Per Month	FCC Unserved Population Delay Cost Per Month	BroadbandNow Unserved Population Delay Cost Per Month
	\$18.72m	\$16.05m	\$40.26m
150/25 Mbps	(\$17.92m)	(\$15.36m)	(\$38.56m)
	\$20.73m	\$17.78m	\$44.59m
300/100 Mbps	(\$19.93m)	(\$17.09m)	(\$42.87m)
	\$22.13m	\$18.98m	\$47.59m
1000/100 Mbps	(\$21.33m)	(\$18.29m)	(\$45.87m)

Notes: See Table D5 notes above.

TABLE D8:  
TEXAS ESTIMATES UNDER ALTERNATIVE ASSUMPTIONS

Economic Gains	If Unserved RDOF Locations Gain Access	If FCC Unserved Population Gains Access	If BroadbandNow Unserved Population Gains Access
	\$4.94b	\$6.84b	\$24.43b
150/25 Mbps	(\$4.73b)	(\$6.54b)	(\$23.38b)
	[\$2.96b]	[\$4.10b]	[\$14.66b]
	\$5.47b	\$7.57b	\$27.06b
300/100 Mbps	(\$5.26b)	(\$7.28b)	(\$26.02b)
	[\$3.28b]	[\$4.52b]	[\$16.27b]
	\$5.84b	\$8.08b	\$28.88b
1000/100 Mbps	(\$5.63b)	(\$7.78b)	(\$27.83b)
	[\$3.50b]	[\$4.85b]	[\$17.33b]
Foregone Gains	RDOF Locations Delay Cost Per Month	FCC Unserved Population Delay Cost Per Month	BroadbandNow Unserved Population Delay Cost Per Month
	\$29.22m	\$40.41m	\$144.46m
150/25 Mbps	(\$27.97m)	(\$38.68m)	(\$138.27m)
	\$32.37m	\$44.76m	\$160.02m
300/100 Mbps	(\$31.14m)	(\$43.02m)	(\$153.83m)
	\$34.54m	\$47.78m	\$170.77m
1000/100 Mbps	(\$32.28m)	(\$46.04m)	(\$164.57m)

Notes: See Table D5 notes above.

TABLE D9:  
**WISCONSIN ESTIMATES UNDER ALTERNATIVE ASSUMPTIONS**

Economic Gains	If Unserved RDOF Locations Gain Access	If FCC Unserved Population Gains Access	If BroadbandNow Unserved Population Gains Access
	\$3.82b	\$2.61b	\$4.44b
150/25 Mbps	(\$3.65b)	(\$2.49b)	(\$4.25b)
	[\$2.29b]	[\$1.57b]	[\$2.66b]
	\$4.23b	\$2.89b	\$4.92b
300/100 Mbps	(\$4.07b)	(\$2.78b)	(\$4.73b)
	[\$2.54b]	[\$1.73b]	[\$2.95b]
	\$4.52b	\$3.08b	\$5.25b
1000/100 Mbps	(\$4.35b)	(\$2.92b)	(\$5.06b)
	[\$2.71b]	[\$1.85b]	[\$3.15b]
Foregone Gains	RDOF Locations Delay Cost Per Month	FCC Unserved Population Delay Cost Per Month	BroadbandNow Unserved Population Delay Cost Per Month
	\$22.60m	\$15.43m	\$26.25m
150/25 Mbps	(\$21.63m)	(\$14.76m)	(\$25.13m)
	\$25.04m	\$17.08m	\$29.08m
300/100 Mbps	(\$24.07m)	(\$16.43m)	(\$27.95m)
	\$26.72m	\$18.24m	\$31.04m
1000/100 Mbps	(\$25.75m)	(\$17.57m)	(\$29.91m)

Notes: See Table D5 notes above.

## END NOTES

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<sup>1</sup> The hold up problem is the power to impede others' ongoing investments. In general, hold up problems arise in scenarios where Entity A makes an initial investment that is called "relationship-specific" because its return depends on Entity A subsequently contracting with Entity B. In these scenarios, if Entity B has information about A's investment, then B has market power to extract rents from A's investment and thereby destroy economic value by requiring a high selling price (high, specifically, relative to what the selling price would be in absence of this market power). Hold up problems are classified in economics terms as one example of inefficient concentration of market power that harms the public interest.

<sup>2</sup> In its annual Broadband Deployment Reports, the Federal Communications Commission cites the 1996 Telecommunications Act as charging the Commission with "encourag[ing] the deployment on a reasonable and timely basis of advanced telecommunications capability to all Americans by removing barriers to infrastructure investment..." (FCC 2021, p.1).

<sup>3</sup> John Busby, Julian Tanberk, and Tyler Cooper, "BroadbandNow Estimates Availability for all 50 States; Confirms that More than 42 Million Americans do not Have Access to Broadband," BroadbandNow Research, May 5, 2021, updated October 21, 2021 ("we manually checked availability of more than 11,000 addresses using Federal Communications Commission (FCC) Form 477 data as the 'source of truth.' Based on the results, we estimated that 42 million Americans do not have the ability to purchase broadband internet.") The discrepancy in unserved locations between the FCC and BroadbandNow databases is largely attributable to the FCC's methodology which only included unserved households in fully unserved census blocks, whereas the BroadbandNow drilled down below the census block level. See <https://broadbandnow.com/research/fcc-broadband-overreporting-by-state>.

<sup>4</sup> Willingness to Pay (or, WTP) is a standard textbook measure of economic gains created by end-users having access to goods and services, including broadband access. See also Appendix B, Glossary of Technical Terms.

<sup>5</sup> Deadweight Loss (or, DWL) is a standard textbook measure of foregone economic gains created by end-users lacking access to goods and services, including broadband access. See also Appendix B, Glossary of Technical Terms.

<sup>6</sup> See Lopez and Kravtin (2021) specifically Appendix C, Lists of Works Cited, "The Underlying Sources of Pole Owners' Market Power: A Combination of Hold Up Problems and Classic Barriers to Entry", and Appendix D, Empirical Methodology and Complete Results: Baseline / Alternative Assumptions.

<sup>7</sup> See FCC (2020) announcing launch of RDOF on February 7, 2020.

<sup>8</sup> See Lopez & Kravtin 2021, pp. 13-15, citing the Liu et al. study.

<sup>9</sup> Nationally, the average number of persons per household is 2.565 according to the U.S. Census Bureau. Therefore, 5.2 million locations would equate to approximately 2 million persons.

<sup>10</sup> Alaska is excluded from our RDOF calculations due to there being no reported RDOF results, dollars, or locations there. Therefore, our nationwide RDOF calculations include only 49 of the 50 states. Our other calculations that are based on FCC and BroadbandNow estimates of unserved populations are calculated for all 50 states.

<sup>11</sup> Appendix D below explains how this study relies on the underlying WTP estimates from the Liu et al. study.

<sup>12</sup> The appropriate discount rate and duration is debatable. We select the lower range of the average service lives of poles, generally identified at 25 to 50 years. A discount rate of 5% is reasonable, although it may be generously high for consumer and household applications, but it is less than the typical cost of capital

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assumptions in the range of 6%.

<sup>13</sup> Poles officially identified as needing replacement by the utility as in situations where a pole has been found non-compliant with safety standards or fails to meet other utility or regulatory requirements such as pole resiliency criteria and placed on a replacement schedule is referred to as “red-tagged.” It is generally accepted that new attachers are not responsible for the cost of pole replacement for red-tagged poles.

<sup>14</sup> See Lopez & Kravtin 2021, Appendix C. and material as reiterated herein in Appendix B.